48240

Patent Application

of

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for

A LASER BRUTING MACHINE

Technical Field

[0001] The present invention relates to a ~~Novel L~~laser ~~B~~bruting ~~M~~machine.

[0002] The diamond has always exercised an irresistible seductive power and acquired an almost mythical fame because it is the most expensive of gems and the hardest of all minerals. Each diamond stone must therefore be studied in detail in order to determine the most advantageous manner to work it with the least loss of weight. In its unpolished form, a diamond is a rather vague crystal form, without any real luster. Only a succession of processes, such as marking, cleaving, sawing, girdling, ~~etc.~~and so forth, gives it its final facet form and brilliance. Girdling is the rounding of the base of sawn (or cleaved) piece so that it has more or less the form of

a polished diamond. In conventional machines to achieve girdling of rough diamond stone, the sawn diamond is mounted on the chuck of a lathe and the desired rounded form is achieved by turning it against another diamond, as the cutting tool. The excess surface of the rough diamond cut with the conventional machine is imprecise. The conventional bruting machine works with lower speed and has the high weight loss. This is due to the cutting force spreadings to other parts of the diamond. As each diamond is unique it has become imperative to develop new techniques ~~in order~~ to improve the productivity of the diamond industry.

Background Art

[0003] A ~~novel~~ laser bruting machine ~~is invented to~~ according to exemplary embodiments of the present invention overcomes the above limitations experienced by conventional bruting machines. With a ~~novel~~ laser bruting machine according to exemplary embodiments of the present invention, bruting becomes a non-contact, very fast process compared to conventional bruting machines. ~~As~~The laser bruting of exemplary embodiments of the present invention is~~being~~ a non-contact process that gives more speed, reduces weight loss significantly and keeps the shape of diamond uniform. In ~~novel~~a laser bruting machine according to exemplary embodiments of the present invention, the computer becomes an important element in cu~~98~~tting ~~of~~the diamond. With the standard software, the computer suggests an optimal cut to have accurate rounded shape of the diamond in which ~~taking~~ dimensions ~~&~~and shape are taken into account. Also the rough diamond stone to be centered and bruted is lit up by illuminating sources and these illuminating sources consist of a plurality of LED's so the eye gets the impression that is always the same side of the stone that is lit and hence the illuminated rough diamond ~~can~~may be watched on closed-circuit television (CCTV) through a video system ~~consist of~~including charged-couple device (CDD) cameras. This is a useful technique, because ~~novel~~a bruting machine according to exemplary embodiments of the present invention may~~can~~ check the process at all times without stopping the machine. Summing up all the advantages, productivity

increases considerably with a ~~novel~~ laser bruting machine according to exemplary embodiments of the present invetion.

~~Disclosure of the Invention~~

Brief Description of the Drawings

[0004] The present invention will be described with greater specific and clarity with reference to following drawings:

[0005] FIG. 1 represents a front view of a bruting machine according to an exemplary embodiment of the present invention.

[0006] FIG. 2 represents a diamond holder.

[0007] FIG. 3 represents a top view of a rough diamond with a possible maximum diameter

[0008] FIG. 4 represents a front view of a setup device.

[0009] FIG. 5 represents a side view of the setup device of FIG. 4.

[0010] FIG. 6 represents a top view of the setup device of FIG. 4.

[0011] FIG. 7 represents a front view of a bruting processing system.

[0012] FIG. 8 represents a front view of a girdle polishing system.

[0013] FIG. 9 represents a block diagram of a ~~B~~beam delivery mechanism.

[0014] FIG. 10 represents a trolley containing a power supply and heat exchanger.

[0015] FIG. 11 represents a block diagram of a cooling system ~~&~~and a chilling system of the heat exchanger.

[0016] FIG. 12 represents a front view of a chilling water tank.

[0017] FIG. 13 represents a front view of a split tank.

[0018] FIG. 14 represents a diamond

[0019] FIG. 15 represents a flow chart.

[0020] FIG. 16a represents a random/initial position of a rough diamond stone.

[0021] FIG. 16b represents a position of a center of a rough diamond stone on an X-axis.

[0022] FIG. 16c represents a position of a rough diamond stone when it is centered.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[0023] A ~~Novel L~~laser ~~B~~bruting ~~m~~Machine according to exemplary embodiments of the present invention includes ~~consist of~~ (i) a diamond holder 8, (ii) a ~~S~~setup device 3, ~~&~~ and (iii) a processing device 4.; The diamond holder 8 ~~consist of~~includes a stitching die 6, a magnetic die 7 and a rough diamond 5.; The setup device 3 ~~consist of~~includes a computer numerical control (CNC) interface, and a video system.; The ~~P~~processing device 4 ~~consists~~includes ~~of~~ a CNC interface, a heat exchanger 25, a video system, a beam delivery mechanism 26, a laser source 27, an RF-Q ~~S~~switch driver 28, a power supply 29 ~~&~~and stabilizer 73.

[0024] A ~~B~~bruting machine 1 according to exemplary embodiments of the present invention ~~which~~ is accommodated on an aluminum frame 2 ~~consists of~~and has three main~~ly three~~ sections.

[0025] ~~(1)~~A first main section is a ~~D~~diamond ~~H~~holder 8.

[0026] ~~(2)~~A second main section is a ~~S~~set up device 3.

[0027] ~~(3)~~A third main section is a ~~P~~processing device 4.

[0028] ~~(1)~~In the ~~D~~diamond ~~H~~holder 8, ~~A~~a rough diamond 5 to be processed for ~~B~~bruting or ~~G~~girdle ~~P~~polishing is stitched on top of the stitching die 6 by adhesive ~~&~~and heat. Due to magnetism of the magnetic die 7, the stitching die 6 is fixed on top of magnetic die 7. The ~~C~~combination of the stitching die 6 and the magnetic die 7 is referred to as the ~~D~~diamond holder 8.

[0029] An automated gemstone/rough diamond stone 5 centering and data management system is provided to the setup device 3. The physical data of a rough diamond stone/gemstone 5 is determined relative to the measured spectral response of light energy incident to a gemstone 5. A ~~G~~gemstone 5 is illuminated by a plurality of light sources such that the spectral response of the gemstone 5 is captured as a pixel data set, gauged, quantified and recorded for future reference via charge-coupled device (CCD) cameras. A setup device 3 provides an imaging station for the automated centering and quantifying physical data of gemstone 5. The video system/imaging station is linked to a computer/analysis station for communicating captured incident light data sets thereto. The analysis station/computer 16 employs a

data processor and model database for assessing the physical data of the gemstone 5 by way of the communicated pixel data sets. The spectral response of a gemstone 5 to the incident light sources is quantified relative to model pixel data sets of the database and recorded for future reference therein. The operation of the setup device 3 is controlled by a control ~~control~~ and instruction set.

[0030] The data processor/control card of the analysis station/computer 16 provides an instruction set for facilitating communication with the setup device 3~~,~~ and analyzing the communicated pixel sets. The instruction set includes analytical and statistical image models, which extract pertinent physical data of gemstone from the pixel data sets. Additionally, the analysis station includes mass storage memory devices for storing the reference value database; analysis instruction sets, and report information, which may include text as well as visual data. The physical data of the gemstone 5 are communicated from the setup device 3 to the computer 21 of processing device 4 by, for example, means of a local area network (LAN).

[0031] The control data processor/control card of the setup device 3 ~~&~~and processing device 4 provides an instruction set for automating the steps necessary to precisely position and operate the imaging hardware. The imaging system/video system of the set up device 3 ~~&~~and the processing device 4 extract consistently and accurately, the size, shape, and proportion information from the images of a gemstone 5 using the data processing instruction set.

[0032] ~~(2)~~The ~~S~~setup ~~D~~device 3 ~~Consist~~includes ~~of~~ a CNC ~~I~~interface ~~&~~and a ~~V~~video ~~S~~system.

[0033] ~~(I) CNC INTERFACE:~~ The CNC ~~I~~interface of the setup device 3 ~~comprising of~~includes a ~~M~~motorized X axis positioner 9, a ~~M~~motorized rotatable platform 11, a ~~M~~motorized up~~/~~ and down positioner 12, ~~D~~drive cards 13,14,15, ~~C~~control card, a ~~C~~computer 16 ~~&~~ and ~~S~~stepper ~~M~~motors.

[0034] ~~(II)~~The ~~V~~video ~~S~~system of setup device 3 ~~consists~~includes ~~of~~an ~~U~~upper CCD ~~C~~camera 17 ~~&~~and a ~~L~~lower CCD camera 18.

[0035] For accurate girdling/rounding or to remove surrounding excess surfaces of a rough diamond/gemstone 5 it is essential that the rough diamond/gemstone 5

should have a rotating/circular motion around its center point. ~~for which it is required that~~ The rough diamond/gemstone 5, along with the stitching die 6, should be placed ~~on~~in the center of the top of the magnetic die 7, and it is preferably done by CNC ~~I~~interface, with the ~~C~~computer 16 with standard software and a ~~M~~monitor 19.

Example:

[0036] Because of the ~~V~~video system, the rough diamond 5 appears on the monitor 19. As the upper CCD camera 17 ~~&~~and the ~~L~~lower CCD camera 18 are being used, one has the option for watching rough diamond 5 either in elevation or plan view. Supposing a surface of the rough diamond 5 is being selected by a 3-point method considering the top view/plan view of the rough diamond 5. Then by mouse clicking, three random end points of the rough diamond 5 are selected and with standard software it gives physical data of the rough diamond 5 and also puts stitching die 6 ~~on~~in the center of the top of the magnetic die 7 automatically using a pusher rod 10 of the motorized X axis positioner 9 ~~&~~ and the motorized rotatable platform 11. The physical data of the rough diamond 5 ~~&~~and the predicted finished diamond 20 ~~can~~may be accessed in the processing device 4 as computers 16 ~~&~~and 21 of the setup device 3 and the processing device 4, respectively, are connected with the LAN.

Functioning of the CNC Interface of the Setup Device 3:

Example:

[0037] Referring to FIG. 16a, assuminge that the center of the rough diamond 5 is P(x,y) and thus it is offset from O(0,0). It vertically represents the initial position of the rough diamond 5 placed on the motorized rotatable platform 11 ~~vertically~~.

[0038] Referring to FIG. 16b, the computerized vision system will measure the angle to rotate and by rotary motion, the center P of the rough diamond 5 is brought onto the X axis ~~through~~by the motorized rotatable platform 11. The ~~S~~stepper motor drives the motorized rotatable platform 11 and hence diamond holder 8, which is placed on the motorized rotatable platform 11, also rotates and takes the position on the X-axis.

[0039] Referring to FIG. 16c, to match the center P with O, ~~P~~pusher rod 10, which is fixed with the ~~M~~motorized X axis positioner 9, pushes P towards O and hence

stitching die 6 is placed ~~on~~in the center of the top of the magnetic die 7. The ~~M~~motorized X axis positioner 9 is driven by a stepper motor.

[0040] If elevation views or plan views of the rough diamond 5 do ~~het~~not appear clearly on the monitor 19, then the ~~M~~motorized up/down positioner 12 comes into action to give a clear image of rough diamond 5 on the monitor 19 by moving vertically. The ~~M~~motorized ~~U~~up/down positioner 12 is driven by a stepper motor.

[0041] Drive cards 13,14 ~~&~~and 15 are connected to the motorized X-axis positioner 9, the motorized up/down positioner 12 ~~&~~and the motorized rotatable platform 11, respectively. Drive cards 13, 14, and 15 are also connected with the computer 16. Drive cards 13, 14, and 15 amplify the electronic signal coming from computer 16 and provides amplified electronic signals to the ~~M~~motorized X axis positioner 9, the ~~M~~motorized up/down positioner 12, ~~&~~and the ~~M~~motorized rotatable ~~p~~platform 11. A contol card, which is placed in the computer 16, controls the movement of the motorized X axis positioner 9, the ~~M~~motorized up/down positioner 12 ~~&~~and the ~~M~~motorized rotatable platform 11. Also, limit switches are provided to each end of the motorized X axis positioner 9, the motorized rotatable platform 11 ~~&~~and the motorized up/down positioner 12 to sense the home & end positions. To switch on or off the drive cards 13, 14, and 15, a drive card power supply 22 is connected to the drive cards 13, 14, and 15.

~~(3)~~ Processing Device 4:

[0042] The ~~D~~diamond holder 8 is carried to the processing device 4 following the process of centering the stitching die 6 on the magnetic die 7. The ~~D~~diamond holder 8 is fixed horizontally on the motorized rotatable platform 23. As the computer 16 of the setup device 3 and the computer 21 of the processing device 4 are connected via the LAN and hence physical data of the rough diamond 5 taken from the setup device 3 is accessed on monitor 24 through standard software installed in computer 21 of processing device 4.

Mechanism of Processing Device 4:

[0043] The ~~P~~processing device 4 ~~consist of~~includes a CNC ~~I~~interface, a ~~H~~heat ~~E~~exchanger 25, a ~~V~~video system, a ~~B~~beam delivery mechanism 26, a ~~L~~laser source 27, a radio frequency (RF)-Q ~~S~~switch driver 28 ~~&~~ and a ~~P~~power supply 29.

[0044] ~~(I)~~ The CNC ~~I~~interface of the processing device 4 ~~consist of~~includes a ~~M~~motorized Y-axis positioner 30, a ~~M~~motorized rotatable platform ~~s~~, a ~~M~~motorized X axis positioner 31, a ~~C~~computer 21, a ~~M~~monitor 24, a CCTV 32, ~~D~~drive cards 33, 34, and 35, a drive card power supply 36 ~~&~~and stepper motors to drive the ~~M~~motorized Y-axis positioner 30, the ~~M~~motorized rotatable platform 23 ~~&~~and the ~~M~~motorized X axis positioner 31.

[0045] ~~(II)~~The ~~H~~heat ~~e~~Exchanger 25 ~~consist of~~includes a ~~C~~cooling system 37, a ~~C~~chilling system 38, and an ~~I~~interlock system 39. The ~~C~~cooling system 37 is associated with de-ionized water circulation from the cooling system 37 to the ~~L~~laser head 43 ~~&~~and the Q-switch 42 and vice versa. The ~~C~~chilling system 38 is associated with water circulation from the ~~H~~heat exchanger 25 to the chilling pump system 48 and vice versa. The ~~C~~chilling pump system 48 ~~consist of~~includes a chilling water tank 70 ~~&~~ and a split tank 71. The ~~H~~heat exchanger 25 is connected to the ~~P~~power supply 29 via interlock cable. The ~~I~~interlock system 39 saves the machine from getting damaged by switching off the power supply 29 automatically if (i) flow and/or (ii) level and/or (iii) temperature of the de-ionized water unnecessarily decreases or increases. The ~~I~~interlock system 39 of the heat exchanger 25 ~~comprising of~~includes a flow light emitting diode (LED) 49, a ~~L~~level LED 50 ~~&~~and a ~~T~~temperature LED 51.

[0046] ~~(III) Video system:~~ The ~~V~~video system of the processing device 4 ~~comprising of~~includes an upper CCD ~~C~~camera 52 and a lower CCD camera 53.

[0047] ~~(IV)~~ The ~~B~~beam delivery mechanism 26 of the processing device 4 ~~consists of~~includes (i) a ~~B~~bruting process system 54 and (ii) a ~~G~~girdle polishing system 55. The ~~B~~bruting process system 54 ~~consists of~~includes (a) a sliding beam bender 56, (b) a lower beam bender 57, ~~&~~and (c) a lower focusing device 58. The ~~G~~girdle ~~P~~polishing system 55 ~~consist of~~includes (a) an upper beam bender 59, and (b) an upper focusing device 60. The ~~S~~sliding beam bender 56, the lower beam bender 57 and the upper beam bender 59 are placed at approximately a 45~~.~~ degree angle~~.~~ with

respect to incoming laser beams. The lower focusing device 58 and the upper focusing device 60 have illuminating sources to illuminate the rough diamond 5. Each illuminating source has a plurality of LED's.

[0048] ~~(V)~~The ~~L~~laser ~~S~~source 27 ~~consist of~~includes a back mirror 40, ~~A~~apertures 41~~,41~~, a Q-switch 42, a ~~L~~laser head 43, a shutter ~~s~~ 44, a ~~polariser~~polarizer 45, a front mirror 46 ~~&~~and a beam expander 47.

[0049] The ~~L~~laser head 43 is the crucial part to generating~~e~~ the laser light. The ~~F~~front mirror 46 and the back mirror 40 amplify~~ies~~ the laser light by providing feedback. The Q-switch 42 is used to store the laser light energy to emit as a burst of high peak power. The ~~S~~safety shutter 44 blocks the laser beam in case of electrical failure. The ~~S~~safety shutter terminates the laser by blocking the laser beam path and preventing emission of laser radiation out of the laser source. The safety shutter 44 is actuated by a toggle switch. The ~~A~~apertures 41~~,41~~ restrict the light amplification along the off-axis of the resonator to provide a sharp frequency band. The ~~B~~beam expander 47 expands the laser beam to minimize its divergence. ~~To polarize~~A laser beam polarizer 45 is used to polarize the laser beam.

[0050] ~~(VI) RF-Q Switch driver 28:~~ To get the pulsed laser output with high peak power, the laser is operated in Q-~~S~~switch mode. The transducer in acoustic-optic Q-switch 42 requires RF power for operation of the Q-switch 42 and such requirement is fulfilled by the RF-Q ~~S~~switch driver 28. The RF source is pulsed at frequencies from 0.1 KHz to 50 KHz corresponding to the desired pulse repetition rate of the laser. The quartz cell being switched with such a high frequency needs cooling. Therefore the Q-switch 42 also becomes cool. To operate Q-~~S~~switch 42 in pulsed mode, the RF-Q ~~S~~switch driver 28 is connected to the Q-Switch 42 and the computer 21. The ~~C~~computer 21 sends the frequency data to the RF-Q switch driver 28 and, accordingly, the laser in the laser source is operated in the Q-switch mode. As the Q-switch 42 is being switched with such a high frequency, it is cooled by circulation of de-ionized water for repetitive operations and therefore the interlock system is provided.

[0051] ~~(VII)~~The ~~P~~power supply 29~~. It~~ ignites and controls the intensity of the laser light emitted by the laser lamp (preferably a Kr/Xe arc lamp). The intensity of the light produced by the lamp is used for pumping the Nd atoms in a Nd:YAG rod. Once the discharge in the lamp is produced, then by changing the current flowing through the lamp, the intensity of the light emitted by the lamp ~~can~~may be controlled. In many applications, the laser is not used continuously and therefore the power supply 29 is provided with a special feature of a standby mode, which keeps alive the discharge in the lamp by producing the optimum current required for the lamp to maintain the discharge in the lamp. This particular arrangement is very useful in increasing the operational life of the lamp and also that of the power supply~~. Because this will~~ which saves the whole process of generating the trigger pulse for igniting the lamp.

Function of the Processing Device 4:

[0052] A diamond holder 8, which ~~consist of~~includes the stitching die 6 and the magnetic die 7, is carried from the setup device 3 and fixed horizontally to the motorized rotatable platform 23. In the bruting process, the laser beam coming from the laser source 27 falls on the sliding beam bender 56 from which it falls on lower beam bender 57 and, hence, the laser beam coming from the lower beam bender 57, which is then focused by the lower focusing device 58, and finally the focused laser beam falls on the gemstone/rough diamond stone 5. ~~And t~~Therefore, the maximum diameter 61 (FIG. 3) of the rough diamond stone/gemstone 5 is achieved by removing excess surface from it by rotary motion and displacement on a particular axis.

[0053] Also, the maximum diameter 61 of the rough diamond 5 is achieved with the girdle polishing process. In the girdle polishing process, the laser beam coming from laser source 27 falls on upper beam bender 59, thereby bypassing the sliding beam bender 56. A laser beam coming from upper beam bender 59, which is then focused by the upper focusing device 60, and hence focused laser beam falls on rough diamond stone 5.

[0054] The ~~A~~application of the ~~B~~bruting process 54 or the ~~G~~girdle polishing process 55 is to obtain the maximum diameter 61 from a rough diamond 5 by

removing excess surrounding surface from the rough diamond 5. After the Bbruting process 54 or the Ggirdle polishing process 55, the shape of the rough diamond 5 is converted into a cylindrical shape in general. To remove excess surrounding surface of the rough diamond 5, the laser beam from the laser source 27 is used.

Procedure for Switching on the Heat Exchanger 25 & and the Power Supply 29:

[0055] The Ppump on/off knob 62 is accommodated in the Hheat exchanger 25, which is kept "on" initially and the Ppump LED 63 is operated by the Ppump on/off knob 62. Also, a digital temperature controlling unit 72 & and the Iinter-lock system 39 are provided to the heat exchanger 25. Then, in Ppower supply 29, test point (T.P.) 64 and the Llamp 65, the switches are switched "on" to trigger the laser lamp of the laser source 27. Also, as the power supply 29 is connected with the heat exchanger 25 via the interlock cable and, therefore, the interlock LED 66 is provided on the power supply 29. The Ppush button switch "Ppush for control" 67 is pressed to start the current setting unit 68. The value displayed in the current setting unit 68 canmay be varied by the current variable knob 69. The Ccurrent setting unit 68 is provided to have a desired wattage for cutting the surrounding excess surfaces of the rough diamond 5. The Hheat exchanger 25 &and the Ppower supply 29 are accommodated in the trolley 99.

Example:

[0056] The required heat in the form of a laser beam to cut the surrounding excess surface of the rough diamond 5 depends on the diamond quality. Supposing that for a rough diamond 5 the required wattage to cut the surrounding excess surface is 25 watts and to have such a value the current variable knob 69 of the power supply 29 is allowed to move until 25 watts is achieved in the watt meter.

Application &and Functioning of the Heat Exchanger 25:

[0057] A large quantity of heat is generated inside the pumping cavity of the laser source 27 when the laser is produced. If the heat is not removed from the pumping cavity of laser source 27, then it will cause lamps and rods to get damaged and therefore a proper arrangement of the heat distribution in terms of the heat exchanger 25 is provided to the processing device 4. The heat from Dde-ionized water is

subsequently removed by the chilling system 38. The temperature of the ~~D~~de-ionized water is regulated by means of a solenoid, which turns outside water flow from the chilling system 38 on and off as required.

[0058] The ~~H~~heat exchanger 25 ~~consist of~~includes (i) a ~~C~~cooling system 37, (ii) a ~~C~~chilling system 38, and (iii) an ~~I~~interlock system 39. The ~~C~~cooling system 37 circulates de-ionized water from the ~~H~~heat exchanger 25 to the ~~L~~laser head 43 ~~&~~and the Q-Switch 42 and vice versa. Also, the chilling system 38 circulates water from the heat exchanger 25 to the chilling pump system ~~s~~and vice versa.

[0059] In the heat exchanger 25, water circulation from the chilling pump system 48 decreases the temperature of incoming de-ionized water at significant level and provides de-ionized water having less temperature to the laser head 43 and Q-switch 42. Flow of water from the chilling system 38 used for decreasing temperature of incoming de-ionized water from the cooling system 37 is ~~getting~~ heated and, hence, the temperature of such water increases. The temperature of such water is required to decrease by means of a chilling pump system 48. The ~~C~~chilling pump system 48 ~~consists of~~includes a split tank 71 and a chilling water tank 70.

Example:

[0060] ~~Supposing~~Assuming the display of the digital temperature controlling unit 72 of the ~~H~~heat ~~E~~exchanger 25 shows a temperature of de-ionized water as being 35~~.~~ degree~~s.~~ ~~C~~celsius. Now, if it is required that the temperature of de-ionized water should be 30~~.~~ degree~~s.~~ ~~C~~celsius~~.~~ then ~~press~~the SET switch of the digital temperature controlling unit 72 is pressed for a few seconds. When the present temperature of de-ionized water (35~~.~~ degree~~s.~~ ~~C.~~celsius) blinks, then ~~press~~the up/down push button switches are pressed until the required temperature of 30~~.~~ degree~~s.~~ ~~C.~~celsius is displayed on the display of the digital temperature controlling unit 72. ~~Press t~~The SET push button switch of digital temperature controlling unit 72 is pressed when 30~~.~~ degree~~s.~~ ~~C.~~celsius is displayed on the display of the digital temperature controlling unit 72. After a few moments, as the temperature of de-ionized water is set at 30~~.~~ degree~~s.~~ ~~C.~~celsius, the chilling pump system 48 of the ~~H~~heat exchanger 25 ~~which~~that decreases the temperature of incoming de-ionized water stops working~~.~~. ~~Though~~

although ~~functioning of~~ the chilling pump system 48 ~~remains~~ continues to function. Functioning of the Chilling Pump System 48 of the Heat Exchanger 25:

[0061] The ~~D~~digital temperature control unit 73 is provided to the chilling water tank 70. When in the display of the digital temperature control unit 73 ~~if~~the value of present water temperature is significantly higher than the value of set water temperature then the split tank 71 starts working, and if the value of present water temperature remains around the value of set water temperature then the split tank 71 stops working. In this way the ~~C~~chilling pump system 48 saves ~~the~~substantial power ~~substantially~~.

[0062] Hence, with the ~~H~~heat exchanger 25, the temperature ~~can~~may be maintained and the same saves the machine from ~~getting~~becoming overheated.

[0063] The ~~IN~~in port 74 of the ~~H~~heat exchanger 25 is connected to one end of a Teflon connector 75 via hose pipe 82 while the other two ends of the Teflon connector 75 are connected to the ~~OUT~~out port 76 of the laser head 43 and the ~~OUT~~out port 77 of the Q-switch 42 via hose pipes 83, and 84, respectively. The ~~OUT~~out port 78 of the ~~H~~heat exchanger 25 is connected to one end of the Teflon connector 79 via hose pipe 85 while the other two ends of the Teflon connector 79 are connected to the ~~IN~~in port 80 of the laser head 43 and the ~~IN~~in port 81 of the Q-switch 42 via hose pipes 86, and 87, respectively. The ~~OUT~~out port 78 of the ~~H~~heat exchanger 25 provides de-ionized water to the ~~L~~laser head 43 and the Q-switch 42 through the ~~IN~~in port 80 and the ~~IN~~in port 81, respectively, while due to laser heat warm de-ionized water comes out from the ~~OUT~~out port 76 and the ~~OUT~~out port 77 of the ~~L~~laser head 43 and the Q-switch 42, respectively, and enters into the ~~H~~heat exchanger 25 through the ~~IN~~in Port 74.

[0064] The ~~C~~chilling ~~OUT~~out port 88 of the ~~H~~heat exchanger 25 is connected to the ~~TN~~in port 89 of the chilling water tank 70 via hose pipe 95 and the ~~OUT~~out port 90 of the ~~C~~chilling water tank 70 is connected to the ~~IN~~in port 91 of the ~~S~~split tank 71 via hosepipe 96. The ~~OUT~~out port 92 of the split tank 71 is connected to the dual port 93 of the chilling water tank 70 via hose pipe 97 and the other end of the dual port 93

of the chilling water tank 70 is connected to the ~~C~~chilling ~~I~~Nin port 94 of the ~~H~~heat exchanger 25 via hose pipe 98.

[0065] Water used to decrease the temperature of de-ionized water becomes warm and comes out from the chilling ~~OUT~~out port 88 of the ~~H~~heat exchanger 25 and travels toward the ~~I~~Nin port 89 of the chilling water tank 70. Then, this warm water travels into the split tank 71 and the split tank 71 decreases the temperature of warm water and provides such water to the chilling water tank 70 and from the chilling water tank ~~s~~water travels into the ~~H~~heat exchanger ~~b~~through the ~~I~~Nin port 94.

Functioning of the Beam Delivery Mechanism 26 of the Processing Device 4:

[0066] If the bruting process is selected on the monitor 24 through software installed in the computer 21, the laser beam falls on the sliding beam bender 56. Then the laser beam falls on the lower beam bender 57 from which it travels towards lower focusing device 58 and, hence, the focused laser beam falls on a side of a rough stone 5 accommodated on diamond holder 8.

[0067] If the ~~G~~girdle polishing process is selected on the monitor 24 through software installed ~~in~~on the computer 21, then the laser beam falls on the upper beam bender 59, thereby bypassing sliding beam bender 56. Now the laser beam passes through upper focusing device 60 and, hence, the focused laser beam falls on rough stone 5 accommodated on diamond holder 8.

[0068] Also, the upper focusing device 60 and the lower focusing device 58 have illuminating components to illuminate the rough diamond 5 by means of a plurality of surrounding LED's for watching the bruting process or the girdle polishing process on the CCTV 32.

Functioning of the CNC Interface of the Processing Device 4:

Motorized Rotatable Platform 23:

[0069] The ~~S~~surrounding excess surface of the rough diamond 5 is removed by a laser beam due to rotation of the motorized rotatable ~~P~~platform 23 on which the diamond holder 8 is mounted horizontally. To drive the motorized rotatable platform 23, a stepper motor is used.

Motorized Y-Axis Positioner 30 and Motorized X-Axis Positioner 31:

[0070] During the ~~B~~bruting process, the laser beam dip~~sping~~ into the rough diamond 5 gradually until the maximum diameter 61 or cylindrical shape of the diamond is achieved for which displacement of the rough diamond 5 through the motorized rotatable platform 23 on Y-axis and/or X-axis is required, which is accomplished by the motorized Y-axis positioner 30 and/or motorized X-axis positioner 31. The ~~M~~motorized Y-axis positioner 30 is mounted on the ~~M~~motorized X-axis positioner 31 in such a way that the ~~M~~motorized Y-axis positioner 30 ~~can~~ travels on the ~~M~~motorized X-axis positioner 31. Displacement of the motorized X-axis positioner 31 and/or the motorized Y-axis positioner 30 is done automatically or by manual data ~~f~~feed through software installed ~~in~~on the computer 21.

[0071] The ~~M~~movement of the ~~M~~motorized Y-axis positioner 30, the ~~M~~motorized X-axis positioner 31, and the rotation of the motorized rotatable platform 23 are controlled by control cards installed in the computer 21.

[0072] As the Y-drive card 33 is connected to the computer 21 ~~&~~and the motorized Y-axis positioner 30, it amplifies the electronic signal coming from the computer 21 and sends the amplified signal to the motorized Y-axis positioner 30. Similarly, the X-drive card 34 and the R-drive card 35 send amplified electronic signals to the ~~M~~motorized X-axis positioner 31 and the ~~M~~motorized Rotatable platform 23, respectively. The Y-drive card 33, the X-drive card 34 and the R-drive card b ~~can~~may be switched on/off through the drive card power supply 36 connected to them. The ~~M~~motorized Y-axis positioner 30 and the ~~M~~motorized X-axis positioner 31 are driven by stepper motors. Also, limit switches are provided to each end of the ~~M~~motorized Y axis positioner 30, the ~~M~~motorized X axis positioner 31 ~~&~~and the motorized rotatable platform 23 to sense the home ~~&~~and end positions.

[0073] A rough diamond 5 to be processed for bruting or girdle polishing ~~can~~may be watched on CCTV 32 through the video system of the processing device 4, which includes ~~consist of~~ the upper CCD camera 52 and the lower CCD camera 53.

[0074] Also, because the laser bruting ~~being~~is a non-contact process, it provides ~~gives~~ more speed, reduces weight loss significantly and keeps the shape of the diamond substantially uniform. In ~~novel~~the laser bruting machine according to

exemplary embodiments of the present invention, the computer becomes an important element in cutting of the diamond/gemstone. With the standard software, the computer suggests an optimal cut to have an accurate rounded shape of the diamond in which ~~taking~~ dimensions ~~&~~and shapes are taken into account. Also, the rough-diamond stone to be centered and bruted is lit up by illuminating sources and these illuminating sources ~~consist of~~include a plurality of LED's so the eye gets the impression that is always the same side of the stone that is lit and hence the illuminated rough diamond ~~can~~may be watched on the CCTV through the video system, which includes the ~~consist of~~ CCD cameras. This is a useful technique, because ~~novel~~the bruting machine according to exemplary embodiments of the present invention ~~can~~may check the process at all times without stopping the machine and the same ~~can~~may be operated by a single person. Summing up all the advantages, productivity increases significantly by using ~~novel~~the laser bruting machine according to exemplary embodiments of the present invention.

[0075] While advantageous embodiments have been chosen to illustrate the invention, it will be understood by those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined in the appended claims.

Abstract of the Disclosure

[0075][0076] A ~~Novel L~~laser ~~B~~bruting machine ~~consists of mainly~~has three sections: (i) a ~~D~~diamond ~~H~~holder, ~~(8)~~ (ii) a ~~S~~set up device ~~(3) &~~ and (iii) a ~~P~~processing device ~~(4)~~. The ~~D~~diamond holder ~~(8) consists of~~includes a rough diamond ~~(5)~~, a stitching die ~~(6) &~~ and a magnetic die ~~(7)~~. ~~Also t~~The rough diamond stone to be centered and bruted is stitched on top of the stitching die ~~(6)~~ by adhesive ~~&~~ and heat. The stitching die ~~(6)~~ is then fixed on top of the magnetic die ~~(7)~~. The ~~S~~setup device ~~(3) consist of~~includes a computer numerical control (CNC) interface ~~&~~ and video system. The diamond ~~which is~~ to be centered, and hence the diamond holder, is put vertically on motorized rotatable platform ~~(11)~~. After completion of centering the diamond, the diamond holder is carried to a processing device ~~&~~and fixed horizontally on a motorized rotatable platform ~~(23)~~ of the processing device ~~(4)~~. The ~~P~~processing device ~~consist of~~includes a CNC ~~I~~interface, a ~~H~~heat ~~E~~exchanger ~~(25)~~, a ~~V~~video system, a ~~B~~beam delivery mechanism ~~(26)~~, a ~~L~~laser source ~~(27)~~, an RF-Q ~~S~~switch driver ~~(28)~~, a ~~P~~power supply ~~(29) &~~and a stabilizer. The ~~B~~beam delivery mechanism of the processing device ~~consists of~~includes (i) a ~~B~~bruting process system and (ii) a ~~G~~girdle polishing system. With ~~the~~ standard software, the computer suggests an optimal cut to ~~have~~provide an accurate rounded shape of the diamond by taking the dimensions ~~&~~ the shape of the diamond into account.